



Doc Code: AP.PRE.REQ

PTO/SB/33 (07-05)

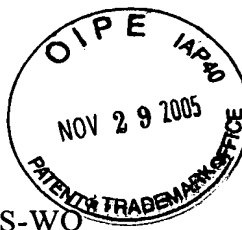
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PRE-APPEAL BRIEF REQUEST FOR REVIEW		Docket Number (Optional) 011765-0302027	
I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to "Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)]  on _____  Signature _____  Typed or printed name _____	Application Number 09/869,086		Filed June 20, 2001
	First Named Inventor JOHNSON et. al		
	Art Unit 2666	Examiner Abelson, Ronald B.	
<p>Applicant requests review of the final rejection in the above-identified application. No amendments are being filed with this request.</p> <p>This request is being filed with a notice of appeal.</p> <p>The review is requested for the reason(s) stated on the attached sheet(s). Note: No more than five (5) pages may be provided.</p> <p>I am the</p> <p><input type="checkbox"/> applicant/inventor.</p> <p><input type="checkbox"/> assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)</p> <p><input checked="" type="checkbox"/> attorney or agent of record.      41844 Registration number _____</p> <p><input type="checkbox"/> attorney or agent acting under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34 _____</p> <p>NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.</p> <p><input type="checkbox"/> *Total of _____ forms are submitted.</p>			
<p>This collection of information is required by 35 U.S.C. 132. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11, 1.14 and 41.6. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.</p> <p>If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.</p>			

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Attorney Docket: 011765-0302027  
Client Reference: MHL/MFG/P9306US-WO

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re PATENT APPLICATION of:

Confirmation Number: 9806

JOHNSON ET AL.

Application No.: 09/869,086

Group Art Unit: 2666

Filed: June 20, 2001

Examiner: Abelson, Ronald B.

Title: DISTRIBUTED HIERARCHICAL SCHEDULING AND ARBITRATION FOR  
BANDWIDTH ALLOCATION

**ATTACHMENT SHEETS TO  
PRE-APPEAL BRIEF CONFERENCE REQUEST**

Mail Stop AF  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

Appellants hereby request that a panel of examiners formally review the legal and factual basis of the rejection in the above-identified application prior to the filing of an appeal brief. Appellants assert that the outstanding rejection (now on appeal by virtue of the concurrently filed Notice of Appeal) is clearly improper based upon errors in facts.

**APPEALED REJECTION**

Appellants appeal the rejection of claims 1-14 under 35 U.S.C. 112, first paragraph, for allegedly failing to comply with the written description requirement. Specifically, the rejection took issue with the language: "N low-bandwidth data sources, M low-bandwidth data destinations, M/N ingress multiplexers, and M/N egress multiplexers," asserting that support for that language was not found in this specification or drawings as originally filed.

**ARGUMENTS FOR TRAVERSAL**

The appealed rejection is improper because support is found in the application, as explained herein. This application was filed under 35 U.S.C. Section 371 based on PCT/GB99/04007 12/01/1999. The filing receipt issued by the USPTO indicates as much.

Moreover, the application claims priority to United Kingdom Patent Application No. 9828143.9, filed December 22, 1998.

Upon entry to the U.S. national phase of PCT/GB99/04007, a Preliminary Amendment, dated June 20, 2001, amended the claims for clarity; however, in substance, the claims entered on file corresponded to the claims as amended during the international phase of PCT/GB99/04007 as attached to the international preliminary examination report. Those amendments had been filed in response to a written opinion issued by the European Patent Office, acting as the International Preliminary Examining Authority. Remarks were submitted as well. A copy of the amendments and the remarks is attached.

Turning to the U.S. national stage, a first Office Action was issued on January 10, 2005, stating that the claims on file were allowable subject to some clarity objections under 35 U.S.C. § 112, relating to the value of "N."

In response, Appellants corrected a typographical error to address the clarity objection. However, subsequently on June 29, 2005, a final Office Action was issued, which rejected the pending claims as a result of the previously submitted claim amendment. Specifically, the Examiner asserted that the features "M/N ingress multiplexers" and "M/N egress multiplexers" were not supported by the originally filed specification.

A Response was subsequently filed which explained where support for the features of M/N ingress multiplexers and M/N egress multiplexers could be found in the application as filed. In that Response, Appellants argued that the PCT publication WO-A-00/38376 which is the application on which the present US application is based, on page 1, in the last paragraph there is reference to "N low-bandwidth data sources and M low-bandwidth output data sources." Thus, the first of the features that the Office Action objected to were clearly supported by the application as originally filed.

Moreover, there is a statement at line 5 of page 6 of the PCT application that states:

"the central interconnect has M/N high-bandwidth ports." Further, referring to the last paragraph on page 1 of the present application's specification, the specification teaches "there is provided a scheduling and arbitration process for use in a digital data switching arrangement of the type in which a central switch under the direction of a master control provides the cross-connections between a number of high-bandwidth ports to which are connected on the ingress side of the central switch a number of ingress multiplexers, one for each high-bandwidth input port and on the egress side a number of egress multiplexers, one for each high-bandwidth output port."

In other words, the present application's specification clearly taught that there are M/N high-bandwidth ports and also that, for each high-bandwidth port, there is an ingress

multiplexer and an egress multiplexer. Therefore, the features of claim 1, i.e., that there are M/N ingress multiplexers and M/N egress multiplexers, were clearly supported by the application as filed.

Furthermore, it was pointed out that there are N input ports and M virtual output queues per ingress multiplexer (see, e.g., the Abstract). Since the number of virtual output queues is, by definition, equal to the number of low-bandwidth output ports (destination) in the switch and there are N (low-bandwidth) input ports per multiplexer, there must be M/N multiplexers in the switch.

Moreover, Appellants' Figure 1 illustrates N as equal to 2 and M as equal to 6. The low-bandwidth input ports are numbered 4 and the low-bandwidth output ports are numbered 5. There are two low-bandwidth input ports per ingress multiplexer (numbered 2) and there are six low-bandwidth output ports in total.

Furthermore, although the ingress and egress multiplexers are drawn as separate components in Figure 1, as stated at the top of page 3, "in practice, a switch is required to support full-duplex ports, such that an ingress multiplexer and its corresponding demultiplexer may be considered a single full-duplex device." Thus, the specification clearly supports the features of current claim 1, e.g., that there are N low-bandwidth data sources, M low-bandwidth data destinations, M/N ingress multiplexers and M/N egress multiplexers.

In response to these arguments, an Advisory Action was issued on September 29, 2005, in which the rejection was maintained. In that Advisory Action, the Examiner asserted that the present application does not claim priority to WO-A-00/38376, which is true. In fact, the application claims priority to United Kingdom Patent Application No. 9828143.9 filed on December 22, 1998. However, reference was made to WO-A-00/38376 in the previous response merely for convenience since the present application is a national stage application of PCT/GB00/04007 (i.e., WO-A-00/38376)." Indeed, on page 2 of the Response to the final Office Action, it was specifically stated "referring to PCT Publication WO-A00/38376 which is application on which the present U.S. application is based . . . ." In other words, the PCT application was referred to merely to demonstrate that the application, as filed, clearly supported the feature to which the Examiner is now objecting.

The Advisory Action also asserted that Figure 1 shows  $M = N = 6$ ; however, that is incorrect. Paragraph number [0016] of Appellant's specification states that "a set of N low-bandwidth ports 21 each fills one of the N input queues 22. An ingress control unit 23 extracts the destination from each of the cells in the input queues and transfers them into a set of M virtual output queues 24. There is one virtual output queue for each low-bandwidth

output port in the switch.” In other words, there are M low-bandwidth output ports in the switch, not in each multiplexer. There are N low-bandwidth ports per multiplexer. Thus, although Figure 1 shows six low-bandwidth input ports and six low-bandwidth output ports, it does not teach “M = N = 6.”

Thus, with reference to the particular example shown in Figure 2, M = 6 as there are 6 low-bandwidth output ports in the switch. It is also clear the N = 2 as there are 2 low-bandwidth input ports per ingress multiplexer. See, for example, the description in relation to Figure 2. As explained above, paragraph [0016] states that (in each ingress multiplexer) there are N low-bandwidth ports, each filling one of N input queues.

Accordingly, the written description of the specification describes the claimed invention in such a way as to reasonably convey to one skilled in the relevant art that the inventors had possession of the claimed invention at the time the application was filed.

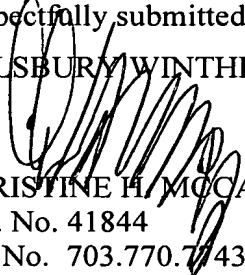
#### CONCLUSION

Therefore, it is respectfully requested that the panel return a decision concurring with Appellant’s position and eliminating the need to file an appeal brief because there are clear legal and/or factual deficiencies in the appealed rejection. Specifically, the subject matter recited of claims 1-14 is in full conformance with the requirements of 35 U.S.C. 112 and allowable.

Please charge any fees associated with the submission of this paper to Deposit Account Number 033975. The Commissioner for Patents is also authorized to credit any over payments to the above-referenced Deposit Account.

Respectfully submitted,

PILLSBURY WINTHROP SHAW PITTMAN LLP



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# PATENT COOPERATION TREATY



From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

**PCT**

**NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**  
(PCT Rule 71.1)

To:

McNEIGHT, D.  
McNeight & Lawrence  
Regent House, Heaton Lane  
Stockport, Cheshire, SK4 1BS  
GRANDE BRETAGNE

Date of mailing  
(day/month/year) 23.03.2001

Applicant's or agent's file reference  
M98/0661/PCT

**IMPORTANT NOTIFICATION**

International application No.  
PCT/GB99/04007

International filing date (day/month/year)  
01/12/1999

Priority date (day/month/year)  
22/12/1998

Applicant  
POWER X LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

**4. REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



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# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference <b>M98/0661/PCT</b>	<div style="display: flex; justify-content: space-between;"> <div><b>FOR FURTHER ACTION</b></div> <div>See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)</div> </div>	
International application No. <b>PCT/GB99/04007</b>	International filing date (day/month/year) <b>01/12/1999</b>	Priority date (day/month/year) <b>22/12/1998</b>
International Patent Classification (IPC) or national classification and IPC <b>H04L12/56</b>		
Applicant <b>POWER X LIMITED et al.</b>		
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 6 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 5 sheets.</p>		
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> <li>I <input checked="" type="checkbox"/> Basis of the report</li> <li>II <input type="checkbox"/> Priority</li> <li>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</li> <li>IV <input type="checkbox"/> Lack of unity of invention</li> <li>V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</li> <li>VI <input type="checkbox"/> Certain documents cited</li> <li>VII <input checked="" type="checkbox"/> Certain defects in the international application</li> <li>VIII <input checked="" type="checkbox"/> Certain observations on the international application</li> </ul>		
Date of submission of the demand  <b>21/06/2000</b>	Date of completion of this report  <b>23.03.2001</b>	
Name and mailing address of the international preliminary examining authority:   <b>European Patent Office</b> <b>D-80298 Munich</b> <b>Tel. +49 89 2399 - 0 Tx: 523656 epmu d</b> <b>Fax: +49 89 2399 - 4465</b>	Authorized officer  <b>Grimaldo, M</b>  <b>Telephone No. +49 89 2399 7513</b>	



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB99/04007

**I. Basis of the report**

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:

**Description, pages:**

1-8	as originally filed			
9	as received on	30/12/2000	with letter of	27/12/2000

**Claims, No.:**

1-14	as received on	30/12/2000	with letter of	27/12/2000
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**Drawings, sheets:**

1/7-7/7	as originally filed
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2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the International application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB99/04007

- ☐ the description,      pages:  
☐ the claims,          Nos.:  
☐ the drawings,        sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Yes: Claims 1-14
	No: Claims
Inventive step (IS)	Yes: Claims 1-14
	No: Claims
Industrial applicability (IA)	Yes: Claims 1-14
	No: Claims

- 2. Citations and explanations**  
**see separate sheet**

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**Cited documents**

The following documents are mentioned in the search report:

- 
- D1: WALLMEIER E ET AL: "TRAFFIC CONTROL IN ATM SWITCHES WITH LARGE BUFFERS", ITC SPECIALISTS SEMINAR, NL, LEIDSCHENDAM, KPN RESEARCH, vol. SEMINAR 9, 1995, pages 45-60**
- D2: WO 96 21303 A (STRATACOM INC) 11 July 1996**
- D3: HUI ZHANG ET AL: "COMPARISON OF RATE-BASED SERVICE DISCIPLINES", COMPUTER COMMUNICATIONS REVIEW, US, ASSOCIATION FOR COMPUTING MACHINERY, NEW YORK, vol. 21, no. 4, 1 September 1991, pages 113-121, ISSN: 0146-4833**

**V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement**

1. Independent claims 1 and 8 relate to a method (claim 1) for scheduling the passage of data cells in a data switching apparatus (claim 8).

The method applied in the data switching apparatus of the invention uses ingress multiplexers and a master control unit to store and maintain tables which are used to fully determine the routing of a cell from any given data source to any given data destination and maintaining a guaranteed bandwidth to any source.

Document D1, considered the closest prior art, also discloses a data switching apparatus. The data switching apparatus uses a series of protocol messages to control the bandwidth allocated to paths between an ingress statistical multiplexing unit (ingress SMU) and an egress statistical multiplexing unit (egress SMU). These messages include a Request message and a Cleardown message. The Request message is generated by an ingress SMU when it detects that the fill state of an output specific logically separate input buffer (virtual output queue) passes through one of a number of thresholds. Conversely, a Cleardown message is produced by an egress SMU when bandwidth has been cleared down

by an ingress SMU.

The rate at which a virtual output queue is served is thus varied dynamically using the multi-threshold mechanism, dependent on these messages.

Moreover a Dynamic Bandwidth Allocation (DBA) is implemented in which each SMU is responsible for its own local resources. The band allocation does not involve any central functions in the switch because a messages protocol to exchange allocation information between ingress and egress statistical multiplexing units is used: allocation information are transferred using ATM cells sent across the core fabric together with normal traffic.

In direct contrast with document D1, the switching apparatus of the present invention, using an ingress port table (27) and an egress port table (28) located in each ingress router, and a central allocation table (29) located in the master control, at no stage requires the exchange of protocol messages between ingress and egress multiplexers: It is never necessary to transmit a bandwidth request message to inform the egress router of rate at which cells need to leave the virtual output queue of an ingress multiplexer.

In other words, unlike D1, the present invention achieves bandwidth control without requiring messages along the communication path through the central switch.

Thus, the present invention achieves a higher transmission rate of data cells while maintaining a guaranteed bandwidth to any source.

It is thus considered that the subject-matter of claim 1 is novel and inventive (Article 33(1)-(3) PCT).

2. Claims 2-7 and 9-14 are directly dependent, respectively, on claim 1 and on claim 8 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

## **VII. Certain defects in the international application**

1. To meet the requirements of Rule 5.1(a)(ii) PCT, document D1 should have been identified in the description and the relevant background art disclosed therein

should be briefly discussed.

2. In the light of the disclosure of document D1 and the new filed set of claims the statement indicating the technical problem to be solved should have required revision (pages 1 and 2).
3. All the sheets (included those containing the set of claim) should have been numbered in consecutive arabic numerals (Rule 11.7 PCT).
4. The opportunity should have also been taken to correct some clerical errors in the application:
  - page 3, line 6: "out co-pending patent application" should have read "our co-pending patent application";
  - claim 1, line 30: "each ingress multiplier" should have read "each ingress multiplexer".

#### **VIII. Certain observations on the international application**

1. The expression "M/N" used four times in claims 1 and 8 is ambiguous (Article 6 PCT) since it is not clear its exact meaning. For example it is not clear how many the "M/N ingress multiplexers" are: M divided N? M? N? several multiplexers with M inputs and N outputs?

Flow bandwidth  
(Gbps)A  
B  
C  
D

Destination Port

A	B	C	D
0.5	0.1	0.1	0.2
0.2	0.2	0.2	0.2
-	0.5	-	0.2
0.1	0.1	0.6	0.2

then the ingress port table such as 77, egress port table such as 78 and central allocation table 79 would be set up by the connection admission and control processor with the following 4- bit values (note here that there will be rounding errors due to the limited resolution of the 4-bit weights):

Ingress Port Table  
(in router 71)

	Source	
	A	B
A	15	6
B	3	6
C	3	6
D	6	6

Ingress Port Table  
(in router 72)

	Source	
	C	D
A	0	3
B	15	3
C	0	15
D	6	5

Egress Port Table  
(in router 71)

	Source
	AB
A	14
B	6
C	6
D	8

Egress Port Table  
(in router 72)

	Source
	CD
A	2
B	12
C	12
D	8

Central Allocation Table  
Destination Router

Source	AB	CB
AB	15	10
CD	10	15

CLAIMS

1. A method of scheduling the passage of data cells from M low-bandwidth data sources (4) to M low-bandwidth data destinations (5), said method being performed by a data switching apparatus including:

M/N ingress multiplexers (2; 71, 72), each arranged to receive data cells from a respective set of N said low-bandwidth data sources (4),

M/N egress multiplexers (3; 74, 75), each arranged to transmit data cells to a respective set of N said low-bandwidth data destinations (5),

a master control unit, and

a central switch having M/N high-bandwidth input ports arranged to receive data cells from respective said ingress multiplexers (2; 71, 72), and M/N high-bandwidth output ports arranged to transmit data cells to respective said egress multiplexers (3; 74, 75), the central switch selectively interconnecting the input ports and output ports, under the direction of the master control unit,

the method including:

each said ingress multiplexer (2; 71, 72) maintaining N input queues (22) for queuing data cells received from the N respective said data sources, and maintaining M virtual output queues (24) for queuing data cells directed to respective said data destinations;

and the method being characterised in that:

each ingress multiplexer further maintains a respective ingress port table (27; 77), each ingress port table having  $N \times M$  entries, each entry corresponding to a respective combination of a said data source for that ingress port and a said data destination,

each ingress multiplexer transfers data cells from said input queues to said virtual output queues with a relative frequency according to value of the corresponding entry of the ingress port table (27; 77);

each ingress multiplexer further maintains a respective egress port table (28; 78), the egress port table having M entries, each entry corresponding to a respective said data destination,

each ingress multiplier transfers data cells from said virtual output queues to said respective input ports of the central switch with a relative frequency according to the value of the corresponding entry of the egress port table (28; 78);

the master control unit maintains a central allocation table (79) having  $(M/N)^2$  entries, each corresponding to a respective combination of an input port and an output port, and

the master control unit controls the central switch to interconnect pairs of said input ports and output ports with a relative frequency according to the value of the corresponding entry of the central allocation table (79);

whereby said ingress port tables (27; 77), egress port tables (28; 78) and central allocation table (79) together determine the bandwidth through the digital data switching apparatus from each said data source (4) to each said data destination (5).

A method according to claim 1 in which each said ingress multiplexer (2; 71, 72), for each virtual output queue (24), transfers data cells to that virtual output queue from said input queues in accordance with a N-way weighted round robin, using N weights determined respectively by the N entries of the ingress port table for that virtual output queue.

3. A method according to claim 2 in which each weight is defined by a number of bits  $w$ , and the N-way weighted round robin for each virtual output queue is implemented by an  $N(2^w-1)$ -way unweighted round robin using a request vector list constructed by interleaving N words of  $(2^w-1)$  bits each, each word corresponding to a respective input queue and having a number of "1"s determined by the entry of the ingress port table for that input queue and that virtual output queue.

4. A method according to claim 3 in which the request vector list is separated into a plurality of round robin blocks, each corresponding to a respective input queue, a first round robin process being performed independently within each block, and a second round robin process being performed to make a selection among the blocks.

5. A method according to any preceding claim in which the ingress port table (27; 77), the egress port table (28; 78) and the central allocation table (79) are all programmed from an external source.

6. A method according to claim 5 in which the external source uses parameters characterizing the length of each virtual output queue and the urgency of each virtual output queue.

7. A method according to claim 6 in which the external source uses a set of sensitivities relating to length, urgency and pseudo-static bandwidth allocation.

8. A digital data switching apparatus for transmitting data from M low-bandwidth data sources (4) to M low-bandwidth data destinations (5), the apparatus including:

M/N ingress multiplexers (2; 71, 72) for receiving data cells from respective sets of N said low-bandwidth data sources (4),

M/N egress multiplexers (3; 74, 75) for transmitting data cells to respective sets of N said low-bandwidth data destinations (5),

a master control unit, and

a central switch having M/N high-bandwidth input ports arranged to receive data cells from respective said ingress multiplexers (2; 71, 72), and M/N high-bandwidth output ports arranged to transmit data cells to respective said egress multiplexers (3; 74, 75), the central switch being arranged selectively to interconnect the input ports and output ports, under the direction of the master control unit,

each said ingress multiplexer (2; 71, 72) being arranged to maintain N input queues (22) for queuing data cells received from respective said data sources, and to maintain M virtual output queues (24) for queuing data cells directed to respective said data destinations;

characterised in that:

each ingress multiplexer (2; 71, 72) is arranged to maintain a respective ingress port table (27; 77), each ingress port table having  $N \times M$  entries, each entry corresponding to a respective combination of a said data source and a said data destination, and each ingress multiplexer is arranged to transfer data cells from said input queues to said virtual output queues with a relative frequency according to value of the corresponding entry of the ingress port table;

each ingress multiplexer is arranged to maintain a respective egress port table (28; 78), the egress port table having  $M$  entries, each corresponding to a respective said data destination (5), and each ingress multiplier is arranged to transfer data cells from said virtual output queues to said respective input ports of the central switch with a relative frequency according to value of the corresponding entry of the egress port table (28; 78),

and the master control unit is arranged to maintain a central allocation table (79) having  $(M/N)^2$  entries, each corresponding to a respective combination of an input port and an output port, and the master control unit controls the central switch to interconnect pairs of said input ports and output ports with a relative frequency according to the value of the corresponding entry of the central allocation table (79);

whereby said ingress port tables (27; 77), egress port tables (28; 78) and central allocation table (79) together determine the bandwidth through the digital data switching apparatus from each said data source (4) to each said data destination (5).

9. An apparatus according to claim 1 in which each said ingress multiplexer is arranged, for each virtual output queue (24), to transfer data cells to that virtual output queue from said input queues (22) in accordance with a  $N$ -way weighted round robin, using  $N$  weights determined respectively by the  $N$  entries of the ingress port table (27; 77) for that virtual output queue.

10. A apparatus according to claim 11 in which each weight has a number of bits  $w$ , and the  $N$ -way weighted round robin for each virtual output queue is implemented by an  $N(2^w - 1)$ -way unweighted round robin using a request vector list constructed by interleaving  $N$  words of  $(2^w - 1)$  bits each, each word corresponding to a respective input queue and having a number of "1"s determined by the entry of the ingress port table for that input queue and that virtual output queue.

11. An apparatus according to claim 10 in which the request vector list is separated into a plurality of round robin blocks, each corresponding to a respective input queue, each ingress multiplexer being arranged to preform a first round robin process independently within each block, and a second round robin process to make a selection among the blocks.

12. A apparatus according to any preceding claim further comprising an external source unit arranged to program the ingress port table (27; 77), the egress port table (28; 78) and the central allocation table (29).

13. An apparatus according to claim 12 in which the external source unit is arranged to operate using parameters characterizing the length of the virtual output queue and the urgency of the virtual output queue.



14. An apparatus according to claim 13 in which the external source unit is arranged to operate using a set of sensitivities relating to the length, urgency and pseudo-static bandwidth allocation.
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Our ref: M98/0661/PCT

Your ref:

27 December 2000

Dear Sirs

**International Patent Application No. PCT/GB99/04007**

I am responding to the written opinion dated 29 September 2000 on the above application. Enclosed in triplicate is a set of replacement claims, and a replacement page 9.

Amendments

In response to the examiner's clarity objections of Section VIII.1, the wording of claims 1 to 7 has been extensively amended, while retaining substantially their original scope. Claim 1 now specifies exactly which limitations define features of the method, and which limitations define features of the device which performs that method. All features in the characterizing portion of the claim all relate to features of the method itself, and thus the category of claim 1 is entirely clear.

The most major change to claim 1 has been in response to the examiner's comment of para VIII.1.2. In the new claim 1, the way in which the various novel tables are used to carry out scheduling have been spelt out in sufficient detail for the features which are essential to the invention to be clearly defined.

In response to the examiner's comment of para VIII.2, apparatus claims 8-14 corresponding in scope to claims 1-7 respectively have been included, none of them dependent on the method claims.

In response to the examiner's comment of section VII.3, reference numerals have been added to the claims, and the first two corrections he kindly noted in section VII.7 have been made.

Amendments to the description to address the examiner's other objections of Section VII are deferred. However, we file a replacement page 9 of the application to correct a couple of minor errors. In the ingress port table, the headings should be C and D, not A and B. In the

egress port table. The first entry (A, AB) should be 14, not 12. In the egress port table entry (D,CD) should be 12, not 8. These corrections can trivially be derived from the other numbers in the text.

### Substantive Issues

As specified in the new independent claims, the ingress multiplexers and master control unit store and maintain tables which are used to fully determine how easy it is for a cell to move between any given data source and any given data destination.

The examiner considers that the closest prior art is D1. This document uses a series of protocol messages to control the bandwidth allocated to paths between an ingress statistical multiplexing unit (SMU) and an egress SMU. Referring to page 51, 2<sup>nd</sup> paragraph, the messages include Request, Cleardown, and Offer messages. The Request message is generated by an ingress SMU when it detects that the fill state of an output specific logically separate input buffer (virtual output queue in the terminology of the present invention) passes through one of a number of thresholds. Conversely, a Cleardown message is produced by an egress SMU when bandwidth has been cleared down by an ingress SMU. The rate at which a virtual output queue is served is thus varied dynamically using the multi-threshold mechanism, dependent on messaging.

It should be noted that the Dynamic Bandwidth Allocation (DBA) in D1 is specifically identified as being a distributed resource management system in which each SMU is responsible for its own local resources – the DBA does not involve any central functions in the switch. The DBA procedures use a messaging protocol to exchange allocation information between ingress and egress SMUs. The DBA messages are transferred using ATM cells sent across the core fabric together with normal traffic (see page 50, lines 16 to 19).

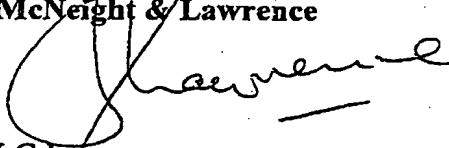
In direct contrast, since the present invention uses an ingress port table (27) and an egress port table (28) located in each ingress router, and a central allocation table (29) located in the master control, at no stage does the equipment of the invention require a messaging protocol between ingress and egress multiplexers (corresponding to the SMUs of D1). It is never necessary to transmit a bandwidth request message to inform the egress router of rate at which cells need to leave the virtual output queue of an ingress multiplexer. In other words, unlike D1, the present invention achieves bandwidth control without requiring messaging along the communication path through the central switch. Thus, the present invention achieves a higher transmission rate of data cells.

Since the principles underlying the present invention are completely different from anything disclosed in D1, novelty and inventive step are clearly present.

On this basis we look forward to receiving a positive international examination report, or, if there are further minor objections to the claims, a second written opinion.

Please acknowledge receipt of this letter and its enclosures by stamping and returning to us the duplicate copy of Form 1037 enclosed.

Yours faithfully  
**McNeight & Lawrence**



J G Lawrence

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